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Controlling and exploiting defects in diamond for Quantum Technologies

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Abstract

Point defects in diamond have great potential for use in a range of quantum technologies. For example as single photon sources and quantum bits that can be exploited in quantum information processing and as the heart of sensors that will transform the way we do analytical science and medical imaging. The negatively charged nitrogen-vacancy centre is an amazing defect in diamond that possesses properties highly suited to many of these applications. However, it does have some challenging weaknesses and full exploitation of the optical and spin properties of this and other defects necessitates that we control their position, orientation and environment to optimise all of the desirable properties simultaneously, especially near the surface of the diamond. I will review our understanding of the production of intrinsic defects and present new data on the creation of defect complexes by doping, electron irradiation, short pulse laser irradiation, ion implantation and annealing. The success and failure of different combinations of processing steps to control and optimise the local defect environment will be discussed and the ongoing search for alternate colour centres with comparable spin properties and superior optical properties will be reviewed.